Contents

Chairman's preface x

Editors' preface xi

SECTION I. PLENARY PAPER

Basic III–V nitride research – past, present and future[1]
B. Monemar 1

SECTION II. InGaN GROWTH AND CHARACTERIZATION

MOVPE of GaInN heterostructures and quantum wells[2]
F. Scholz, J. Off, A. Sohmer, V. Syganow, A. Dörnen and O. Ambacher 8

Thermodynamic study on phase separation during MOVPE growth of $In_xGa_{1-x}N$
A. Koukitu and H. Seki 13

Unstable mixing region in wurtzite $In_{1-x-y}Ga_xAl_yN$
T. Matsuoka 19

The formation of crystalline defects and crystal growth mechanism in $In_xGa_{1-x}N$/GaN heterostructure grown by metalorganic vapor phase epitaxy
Y. Kawaguchi, M. Shimizu, M. Yamaguchi, K. Hiramatsu, N. Sawaki, W. Taki, H. Tsuda, N. Kuwano, K. Oki, T. Zheleva and R.F. Davis 24

Growth and properties of InGaN nanoscale islands on GaN
S. Keller, B.P. Keller, M.S. Minsky, J.E. Bowers, U.K. Mishra, S.P. DenBaars and W. Seifert 29

Phase separation in annealed InGaN/GaN multiple quantum wells
L.T. Romano, M.D. McCluskey, B.S. Krusor, D.P. Bour, C. Chua, S. Brennan and K.M. Yu 33

Vapor-phase epitaxy of $In_xGa_{1-x}N$ using chloride sources
N. Takahashi, R. Matsumoto, A. Koukitu and H. Seki 37

Low-temperature growth of GaN and $In_xGa_{1-x}N$ films on glass substrates
Y. Sato, A. Kurosaki and S. Sato 42

Growth of GaN and InGaN prepared by a hot wall beam epitaxy system with NH_3
F. Tanoue, S. Sakakibara, M. Ohbora, K. Ishino, A. Ishida and H. Fujiyasu 47

Localized luminescence centers of InGaN
H. Kanie, N. Tsukamoto, H. Koami, T. Kawano and T. Totsuka 52

Growth temperature effects on $In_xGa_{1-x}N$ films studied by X-ray and photoluminescence
H.-C. Lin, C.-K. Shu, J. Ou, Y.-C. Pan, W.-K. Chen, W.-H. Chen and M.-C. Lee 57

SECTION III. SELECTIVE AREA GROWTH AND LATERAL OVERGROWTH

High-quality InGaN MQW on low-dislocation-density GaN substrate grown by hydride vapor-phase epitaxy[2]
C. Sasaoka, H. Sunakawa, A. Kimura, M. Nido, A. Usui and A. Sakai 61

Hydride vapor-phase epitaxy growth of high-quality GaN bulk single crystal by epitaxial lateral overgrowth
T. Shibata, H. Sone, K. Yahashi, M. Yamaguchi, K. Hiramatsu, N. Sawaki and N. Itoh 67

Selective MOVPE of GaN and $Al_xGa_{1-x}N$ with smooth vertical facets
T. Akasaka, Y. Kobayashi, S. Ando, N. Kobayashi and M. Kumagai 72

Sub-micron fine structure of GaN by metalorganic vapor phase epitaxy (MOVPE) selective area growth (SAG) and buried structure by epitaxial lateral overgrowth (ELO)
H. Matsushima, M. Yamaguchi, K. Hiramatsu and N. Sawaki 78

Spatial control of InGaN luminescence by MOCVD selective epitaxy
D. Kapolnek, S. Keller, R.D. Underwood, S.P. DenBaars and U.K. Mishra 83

Selective area growth of GaN/AlN heterostructures
D. Marx, Z. Kawazu, T. Nakayama, Y. Mihashi, T. Takami, M. Nunoshita and T. Ozeki 87

---

[1] Plenary paper.
[2] Invited paper.

Optical and structural properties of lateral epitaxial overgrown GaN layers
J.A. Freitahs, Jr., O.-H. Nam, T.S. Zheleva and R.F. Davis 92
Lateral overgrowth of GaN on patterned GaN/sapphire substrate via selective metal organic vapour phase epitaxy: a route to produce self supported GaN substrates[3]
B. Beaumont, P. Gibart, M. Vaille, S. Haffouz, G. Nataf and A. Bouillé 97

SECTION IV. QUANTUM WELL AND NANOSTRUCTURES

Properties of InGaN multiple-quantum-well heterostructures grown by metalorganic chemical vapor deposition
P.A. Grudowski, C.J. Eiting and R.D. Dupuis 103
Shutter control method for control of Al contents in AlGaN quasi-ternary compounds grown by RF-MBE
A. Kikuchi, M. Yoshizawa, M. Mori, N. Fujita, K. Kushi, H. Sasamoto and K. Kishino 109
Growth of $Al_xGa_{1-x}N$ ($0 \leqq x \leqq 0.2$) and fabrication of AlGaN/GaN superlattice by RF-source MBE
K. Nozawa, N. Maeda, Y. Hirayama and N. Kobayashi 114
Electronic structure and optical properties of GaN–$Ga_{0.7}Al_{0.3}N$ quantum wells along the [0 0 0 1] direction
P. Bigenwald, P. Christol, A. Alemu and B. Gil 119
Interface control of GaN/AlGaN quantum well structures in MOVPE growth
T. Shirasawa, N. Mochida, A. Inoue, T. Honda, T. Sakaguchi, F. Koyama and K. Iga 124
Photoluminescence study of GaN/InGaN multiquantum well structures at room temperature
S. Saito, M. Onomura, J. Nishio, L. Sugiura, K. Itaya, H. Sugawara and M. Ishikawa 128
Reduction of etch pit density on GaN by InGaN-strained SQW
Y. Ono, Y. Iyechika, T. Takada, K. Inui and T. Matsue 133
Self-organization of GaN/$Al_{0.18}Ga_{0.82}N$ multi-layer nano-columns on (0 0 0 1) Al_2O_3 by RF molecular beam epitaxy for fabricating GaN quantum disks
M. Yoshizawa, A. Kikuchi, N. Fujita, K. Kushi, H. Sasamoto and K. Kishino 138
Plastic versus elastic misfit relaxation in III-nitrides grown by molecular beam epitaxy
G. Feuillet, B. Daudin, F. Widmann, J.L. Rouvière and M. Arléry 142
Real-time observations of the GaN dot formation by controlling growth mode on the AlGaN surface in gas-source molecular beam epitaxy
X.Q. Shen, S. Tanaka, S. Iwai and Y. Aoyagi 147

SECTION V. BULK AND HOMOEPITAXY

Bulk and homoepitaxial GaN-growth and characterisation[2]
S. Porowski 153
Interaction of N_2 molecule with liquid Ga surface – quantum mechanical calculations (DFT)
S. Krukowski, Z. Romanowski, I. Grzegory and S. Porowski 159
Characterization of bulk GaN grown by sublimation technique
Y. Naoi, K. Kobatake, S. Kurai, K. Nishino, H. Sato, M. Nozaki, S. Sakai and Y. Shintani 163
Blue light-emitting diodes on GaN substrates, growth and characterization
A. Pelzmann, C. Kirchner, M. Mayer, V. Schwegler, M. Schauler, M. Kamp, K.J. Ebeling, I. Grzegory, M. Leszczynski, G. Nowak and S. Porowski 167

SECTION VI. GROWTH ON VARIOUS SUBSTRATES

Growth of single crystal GaN on a Si substrate using oxidized AlAs as an intermediate layer
N.P. Kobayashi, J.T. Kobayashi, W.-J. Choi, P.D. Dapkus, X. Zhang and D.H. Rich 172
Thermal stability of GaN on (1 1 1) Si substrate
H. Ishikawa, K. Yamamoto, T. Egawa, T. Soga, T. Jimbo and M. Umeno 178
Growth of hexagonal GaN thin films on Si(1 1 1) with cubic SiC buffer layers
J.-H. Boo, S.A. Ustin and W. Ho 183
Direct growth of GaN on (0 0 0 1) 6H–SiC by low-pressure MOVPE with a flow channel
M. Kurimoto, M. Shibata, J. Yamamoto, M. Tsubamoto, T. Honda and H. Kawanishi 189
Origin of cracks in GaN/AlGaN DH structure grown on 6H-SiC by metalorganic vapor phase epitaxy
J. Yamamoto, M. Kurimoto, M. Shibata, T. Honda and H. Kawanishi 193

---

[3] Late news paper.

MOVPE growth of GaN and LED on (1 1 1) $MgAl_2O_4$
S. Duan, X. Teng, Y. Wang, G. Li, H. Jiang, P. Han and D.-C. Lu 197
Epitaxial orientation and a growth model of (0 0 · 1) GaN thin film on (1 1 1) spinel substrate
H. Ohsato, T. Kato, S. Koketsu, R.D. Saxena and T. Okuda 202
$LiGaO_2$ single crystal as a lattice-matched substrate for hexagonal GaN thin films
T. Ishii, Y. Tazoh and S. Miyazawa 208
ECR-MBE growth of GaN on $LiGaO_2$
M. Okada, Y. Higaki, T. Yanagi, Y. Shimizu, Y. Nanishi, T. Ishii and S. Miyazawa 213
Promising characteristics of GaN layers grown on amorphous silica substrates by gas-source MBE
K. Iwata, H. Asahi, K. Asami, A. Ishida, R. Kuroiwa, H. Tampo, S. Gonda and S. Chichibu 218
Structural properties and intense ultraviolet emission of polycrystalline GaN films on AlN ceramics grown by N plasma-excited CVD
S. Kato, Y. Yamada and T. Taguchi 223
Fabrication of $Pb(Zr,Ti)O_3$/MgO/GaN/GaAs structure for optoelectronic device applications[3]
A. Masuda, S. Morita, H. Shigeno, A. Morimoto, T. Shimizu, J. Wu, H. Yaguchi and K. Onabe 227

SECTION VII. INITIAL GROWTH, BUFFER LAYERS AND INTERFACES

Dislocation generation in GaN heteroepitaxy[2]
X.H. Wu, P. Fini, E.J. Tarsa, B. Heying, S. Keller, U.K. Mishra, S.P. DenBaars and J.S. Speck 231
Study on the initial stages of heteroepitaxial growth of hexagonal GaN on sapphire by plasma assisted MBE
K. Balakrishnan, H. Okumura and S. Yoshida 244
Effect of initial layers for high-quality GaN growth by hot-wall epitaxy
G.N. Jeon, H.S. Kang, K.W. Chae, W.K. Jung, D.I. Yang and C.H. Lee 250
Structural investigation of sapphire surface after nitridation
T. Hashimoto, Y. Terakoshi, M. Ishida, M. Yuri, O. Imafuji, T. Sugino, A. Yoshikawa and K. Itoh 254
Nitridation of GaAs(1 1 1) by dimethyl-hydrazine (DMHy) with As_4 molecular beam
A. Hashimoto, T. Motizuki, Y. Kurumi and A. Yamamoto 259
Atomically flat (0 0 1)GaAs surface prepared by two-step atomic-hydrogen treatment and its application to heteroepitaxy of GaN
H. Nagano, Z. Qin, A. Jia, Y. Kato, M. Kobayashi, A. Yoshikawa and K. Takahashi 265
Epitaxial growth of GaN layers with double-buffer layers
K. Uchida, K. Nishida, M. Kondo and H. Munekata 270
Initial growth of GaN on sapphire(0 0 0 1) using an amorphous buffer layer formed at room temperature by RF-MBE
N. Ohshima, H. Yonezu, S. Yamahira and K. Pak 275
Characterization of ALN buffer layers on (0 0 0 1)-sapphire substrates
Y.-M. Le Vaillant, R. Bisaro, J. Olivier, O. Durand, J.-Y. Duboz, S. Ruffenach-Clur, O. Briot, B. Gil and R.-L. Aulombard 282
The influence of thickness on properties of GaN buffer layer and heavily Si-doped GaN grown by metalorganic vapor-phase epitaxy
X. Liu, L. Wang, D.-C. Lu, D. Wang, X. Wang and L. Lin 287
Crystal quality and surface structure of sapphire and buffer layers on sapphire revealed by crystal truncation rod scattering
M. Tabuchi, N. Matsumoto, Y. Takeda, T. Takeuchi, H. Amano and I. Akasaki 291
Interface structure of GaN on sapphire (0 0 0 1) studied by transmission electron microscope
T. Onitsuka, T. Maruyama, K. Akimoto and Yoshio Bando 295

SECTION VIII. GROWTH MONITORING AND PROCESSING

Influence of N_2 carrier gas on surface stoichiometry in GaN MOVPE studied by surface photoabsorption
Y. Kobayashi and N. Kobayashi 301
Spectroscopic ellipsometry study on initial growth stages of GaN films on GaAs(0 0 1) in low-pressure MOVPE
Y. Taniyasu, R. Ito, N. Shimoyama, M. Kurihara, A. Jia, Y. Kato, M. Kobayashi, A. Yoshikawa and K. Takahashi 305
In situ real-time studies of GaN growth on 6H–SiC(0 0 0 1) by low-energy electron microscopy (LEEM)
A. Pavlovska, E. Bauer, V.M. Torres, J.L. Edwards, R.B. Doak, I.S.T. Tsong, V. Ramachandran and R.M. Feenstra 310
Optical emission spectroscopy as the monitoring tool in ECR-MBE growth of GaN
Y. Chiba, Y. Shimizu, T. Tominari, S. Hokuto and Y. Nanishi 317
Effects of hydrogen on carbon incorporation in GaN grown by remote plasma-enhanced metal-organic chemical vapor deposition
C. Sone, M.H. Kim, H.J. Kim and E. Yoon 321

Study of the pyrolysis of tertiarybutylhydrazine and GaN film growth
S. Nishide, T. Yoshimura, Y. Takamatsu, A. Ichige, K. Pak, N. Ohshima and H. Yonezu 325
Low-pressure chemical vapor deposition of GaN epitaxial films
M. Topf, G. Steude, S. Fischer, W. Kriegseis, I. Dirnstorfer, D. Meister and B.K. Meyer 330
Comparison of hydrogen and nitrogen as carrier gas for MOVPE growth of GaN
O. Schön, B. Schineller, M. Heuken and R. Beccard 335
Preparation of GaN film of low carrier density by the HWE system with Ga and TMG sources
S. Chu, K. Fujimura, D. Suzuki, S. Sakakibara, F. Tanoue, A. Ishida, K. Ishino, K. Aiki and H. Fujiyasu 340
MOVPE growth of high quality III-nitride material for light emitting device applications in a multiwafer system
C. von Eichel-Streiber, O. Schön, R. Beccard, D. Schmitz, M. Heuken and H. Jürgensen 344

SECTION IX. MBE GROWTH OF GaN

MBE growth and doping of III–V nitrides[2]
H.M. Ng, D. Doppalapudi, D. Korakakis, R. Singh and T.D. Moustakas 349
Crystal growth of GaN at resonance point of nitrogen-ECR plasma
T. Inushima, T. Oda, T. Ashino, T. Matsushita, T. Shiraishi, S. Yasaka and S. Ohoya 354
Effect of thermal annealing on electrical properties in MBE-grown n-type GaN films
N. Maeda, K. Nozawa, Y. Hirayama and N. Kobayashi 359
Analysis of MBE growth mode for GaN epilayers by RHEED
H. Okumura, K. Balakrishnan, H. Hamaguchi, T. Koizumi, S. Chichibu, H. Nakanishi, T. Nagatomo and S. Yoshida 364
STM observation of wurtzite GaN(0 0 0 1) surface grown by MBE on 6H-SiC substrates
Y. Nakada and H. Okumura 370
Thermally induced strain in MBE grown GaN layers
H. Heinke, V. Kirchner, S. Einfeldt, U. Birkle and D. Hommel 375
Dependence of GaN MOMBE growth on nitrogen source: ECR plasma gun structure and monomethyl-hydrazine
T. Yaguchi, S. Yonemura, H. Tsuchiya, N. Shimoyama, T. Suemasu and F. Hasegawa 380
Epitaxial growth of GaN with a high growth rate of 1.4 μm/h by RF-radical source molecular beam epitaxy
N. Fujita, M. Yoshizawa, K. Kushi, H. Sasamoto, A. Kikuchi and K. Kishino 385

SECTION X. CUBIC GaN GROWTH AND CHARACTERIZATION

Growth of cubic III-nitrides by gas source MBE using atomic nitrogen plasma: GaN, AlGaN and AlN
H. Okumura, H. Hamaguchi, T. Koizumi, K. Balakrishnan, Y. Ishida, M. Arita, S. Chichibu, H. Nakanishi, T. Nagatomo and S. Yoshida 390
Growth condition dependence of GaN crystal structure on (0 0 1)GaAs by hydride vapor-phase epitaxy
H. Tsuchiya, K. Sunaba, T. Suemasu and F. Hasegawa 395
Growth of c-GaN on carbonized Si(1 0 0) surfaces
A. Yamada, T. Maruyama and K. Akimoto 401
A study of initial growth mechanism of c-GaN on GaAs(1 0 0) by molecular beam epitaxy
R. Kimura, Y. Gotoh, T. Nagai, Y. Uchida, T. Matsuzawa, K. Takahashi and C.-G. Schulz 406
Optically pumped stimulated emission from cubic GaN/AlGaN double heterostructure grown on GaAs(1 0 0) using metalorganic vapor-phase epitaxy
A. Nakadaira and H. Tanaka 411
Optical transitions in cubic GaN grown on GaAs(1 0 0) substrates by metalorganic vapor-phase epitaxy
J. Wu, H. Yaguchi, K. Onabe, R. Ito and Y. Shiraki 415
Investigation of luminescence properties of GaN single crystals grown on 3C-SiC substrates
J. Wu, H. Yaguchi, H. Nagasawa, Y. Yamaguchi, K. Onabe, Y. Shiraki and R. Ito 420
High-resolution X-ray diffraction analysis of cubic GaN grown on (0 0 1)GaAs by RF-radical source molecular beam epitaxy
Z.X. Qin, H. Nagano, Y. Sugure, A.W. Jia, M. Kobayashi, Y. Kato, A. Yoshikawa and K. Takahashi 425
Raman characterization of cubic GaN epitaxial layers grown on (0 0 1)GaAs and GaP substrates
V.Yu. Davydov, I.N. Goncharuk, A.N. Smirnov, R.V. Zolotareva, A.V. Subashiev, T.S. Cheng and C.T. Foxon 430
Raman scattering characterization of group III-nitride epitaxial layers including cubic phase
H. Harima, T. Inoue, S.-i. Nakashima, H. Okumura, Y. Ishida, S. Yoshida and H. Hamaguchi 435

SECTION XI. GROWTH OF BN, AlN, AND InN

MOCVD of BN and GaN thin films on silicon: new attempt of GaN growth with BN buffer layer
J.-H. Boo, C. Rohr and W. Ho 439

GaN/BAlN heterostructure grown on a (0 0 0 1)6H–SiC substrate by metalorganic vapor phase epitaxy
M. Shibata, M. Kurimoto, J. Yamamoto, T. Honda and H. Kawanishi 445
Growth of AlN films by magnetron sputtering
S. Uchiyama, Y. Ishigami, M. Ohta, M. Niigaki, H. Kan, Y. Nakanishi and T. Yamaguchi 448
Formation of cubic-AlN layer on MgO(1 0 0) substrate
S. Okubo, N. Shibata, T. Saito and Y. Ikuhara 452
Energy loss spectrum of AlN in the 6–120 eV region
Q. Guo, M. Nishio, H. Ogawa and A. Yoshida 457
Characterization of MOVPE-grown InN layers on α-Al_2O_3 and GaAs substrates
A. Yamamoto, T. Shin-ya, T. Sugiura and A. Hashimoto 461
Deposition of InN thin films by radio frequency magnetron sputtering
Q. Guo, N. Shingai, M. Nishio and H. Ogawa 466

SECTION XII. InNAs, GaNAs(P) GROWTH AND CHARACTERIZATION

Growth of InNAs on GaAs(1 0 0) substrates by molecular-beam epitaxy
S. Sakai, T.S. Cheng, T.C. Foxon, T. Sugahara, Y. Naoi and H. Naoi 471
Nitridation of InAs(1 0 0) surface in a flowing NH_3: formation of InNAs?
A. Yamamoto, T. Shin-ya, T. Sugiura, M. Ohkubo and A. Hashimoto 476
Transmission electron microscopy investigation of InNAs on GaAs grown by molecular beam epitaxy
M. Hao, S. Sakai, T. Sugahara, T.S. Cheng and C.T. Foxon 481
Metalorganic vapor-phase epitaxy of $GaP_{1-x-y}As_yN_x$ quaternary alloys on GaP
G. Biwa, H. Yaguchi, K. Onabe and Y. Shiraki 485
Metalorganic molecular beam epitaxy of GaNAs alloys on (0 0 1)GaAs
K. Uesugi and I. Suemune 490
Temperature dependence of photoluminescence of $GaP_{1-x}N_x$ alloys
H. Yaguchi, G. Biwa, S. Miyoshi, D. Aoki, K. Arimoto, K. Onabe, R. Ito and Y. Shiraki 496
Theoretical study of conduction band edge formation in $GaP_{1-x}N_x$ alloys using a tight-binding approximation
H. Yaguchi 500

SECTION XIII. DOPING

Theory of doping and defects in III–V nitrides[2]
C.G. Van de Walle, C. Stampfl and J. Neugebauer 505
Doping characteristics and electrical properties of Mg-doped AlGaN grown by atmospheric-pressure MOCVD
M. Suzuki, J. Nishio, M. Onomura and C. Hongo 511
Studies of p-GaN grown by MBE on GaAs(1 1 1)B
C.T. Foxon, T.S. Cheng, N.J. Jeffs, J. Dewsnip, L. Flannery, J.W. Orton, I. Harrison, S.V. Novikov, B.Ya. Ber and Yu.A. Kudriavtsev 516
Growth condition dependence of Mg-doped GaN film grown by horizontal atmospheric MOCVD system with three layered laminar flow gas injection
H. Tokunaga, I. Waki, A. Yamaguchi, N. Akutsu and K. Matsumoto 519
Compensation effects in Mg-doped GaN epilayers
L. Eckey, U. Von Gfug, J. Holst, A. Hoffmann, B. Schineller, K. Heime, M. Heuken, O. Schön and R. Beccard 523
Thermal ionization energy of Si and Mg in AlGaN
M. Katsuragawa, S. Sota, M. Komori, C. Anbe, T. Takeuchi, H. Sakai, H. Amano and I. Akasaki 528
Electronic structures of p-type GaN codoped with Be or Mg as the acceptors and Si or O as the donor codopants
T. Yamamoto and H. Katayama-Yoshida 532
Mg concentration dependence of optical properties in GaN : Mg
E. Oh, M. Park, S. Kang, H. Cho, B. Kim, M. Yoo, H. Song and T. Kim 537

SECTION XIV. DEFECTS

Characterization of mid-gap states in HVPE and MOVPE-grown n-type GaN
P. Hacke, H. Okushi, T. Kuroda, T. Detchprohm, K. Hiramatsu and N. Sawaki 541
Time resolved spectroscopy of mid-band-gap emissions in Si-doped GaN
R. Seitz, C. Gaspar, T. Monteiro, E. Pereira, M. Leroux, B. Beaumont and P. Gibart 546

Precise control of pn-junction profiles for GaN-based LD structures using GaN substrates with low dislocation densities
N. Kuroda, C. Sasaoka, A. Kimura, A. Usui and Y. Mochizuki 551
On the nature of the 3.41 eV luminescence in hexagonal GaN
S. Fischer, G. Steude, D.M. Hofmann, F. Kurth, F. Anders, M. Topf, B.K. Meyer, F. Bertram, M. Schmidt, J. Christen, L. Eckey, J. Holst, A. Hoffmann, B. Mensching and B. Rauschenbach 556
Investigations of undoped and Mg-doped wurtzite GaN with luminescence-detected paramagnetic resonance in the 4 mm band
F.K. Koschnick, K. Michael, J.-M. Spaeth, B. Beaumont, P. Gibart, J. Off, A. Sohmer and F. Scholz 561
High-concentration hydrogen in unintentionally doped GaN
J.-P. Zhang, X.-L. Wang, D.-Z. Sun, X.-B. Li and M.-Y. Kong 566
Effects of nitrogen vacancy on optical properties of nitride semiconductors
E. Yamaguchi and M.R. Junnarkar 570
EBIC observation of n-GaN grown on sapphire substrates by MOCVD
K. Yamamoto, H. Ishikawa, T. Egawa, T. Jimbo and M. Umeno 575

SECTION XV. LOCALIZED EXCITONS

Excitonic enhanced optical gain of GaN/AlGaN quantum wells with localized states[2]
T. Uenoyama 580
Optical gain process in wide-gap semiconductors: possibilities of blue-light bi-exciton lasing in quantum-well and quantum-dot lasers[2]
M. Sugawara 585
Time-resolved electroluminescence spectroscopy of $In_xGa_{1-x}N$ single quantum well LEDs
Y. Narukawa, S. Saijyo, Y. Kawakami, Sz. Fujita, Sg. Fujita and S. Nakamura 593
Evidence for quantum-dot-like states in GaInN/GaN quantum wells?
J.S. Im, S. Heppel, H. Kollmer, A. Sohmer, J. Off, F. Scholz and A. Hangleiter 597
Localized exciton and its stimulated emission in InGaN multiple quantum wells
A. Satake, Y. Masumoto, T. Miyajima, T. Asatsuma and M. Ikeda 601
Emission mechanism of localized excitons in $In_xGa_{1-x}N$ single quantum wells
Y. Narukawa, K. Sawada, Y. Kawakami, Sz. Fujita, Sg. Fujita and S. Nakamura 606
Effects of Si-doping on luminescence properties of $In_xGa_{1-x}N$ epitaxial layers
Y. Yamada, T. Taguchi, F. Sasaki, S. Kobayashi and T. Tani 611

SECTION XVI. STRAIN EFFECT AND EXCITONS

Quantum-confined Stark effect in strained GaInN quantum wells on sapphire (0 0 0 1)
T. Takeuchi, S. Sota, H. Sakai, H. Amanoa, I. Akasaki, Y. Kaneko, S. Nakagawa, Y. Yamaoka and N. Yamada 616
Valence band splitting and luminescence Stokes shift in GaInN/GaN thin films and multiple quantum well structures
C. Wetzel, T. Takeuchi, H. Amano and I. Akasaki 621
Effect of crystal symmetry, strain and spin–orbit coupling on electronic and optical properties of III-nitrides
M. Suzuki and T. Uenoyama 625
Local strain distribution of hexagonal GaN pyramids
A. Hoffmann, H. Siegle, A. Kaschner, L. Eckey, C. Thomsen, J. Christen, F. Bertram, M. Schmidt, K. Hiramatsu, S. Kitamura and N. Sawaki 630
Strain investigations of wurtzite GaN by Raman phonon diagnostics with photoluminescence supplement
M. Klose, N. Wieser, G.C. Rohr, R. Dassow, F. Scholz and J. Off 634
The exciton–polariton effect on the fluorescence properties of GaN on sapphire
B. Gil, A. Hoffmann, S. Clur, L. Eckey, O. Briot and R.-L. Aulombard 639
Effect of piezo electric field on emission characteristics in GaN/AlGaN quantum wells
T. Honda, T. Miyamoto, T. Sakaguchi, H. Kawanishi, F. Koyama and K. Iga 644
The study of piezoelectric effect in wurtzite GaN/InGaN/AlGaN multilayer structures
W. Liu, K.L. Teo, M.F. Li, S.J. Chua, K. Uchida, H. Tokunaga, N. Akutsu and K. Matsumoto 648
Exciton binding energies and band gaps in GaN bulk crystals
K. Reimann, M. Steube, D. Fröhlich and S.J. Clarke 652

SECTION XVII. SOLID STATE PHYSICS AND OPTICAL CHARACTERIZATION

Phonon spectrum of wurtzite GaN and AlN. Experiment and theory
V.Yu. Davydov, Yu.E. Kitaev, I.N. Goncharuk, A.M. Tsaregorodtsev, A.N. Smirnov, A.O. Lebedev, V.M. Botnaryk, Yu.V. Zhilyaev, M.B. Smirnov, A.P. Mirgorodsky and O.K. Semchinova 656

Raman studies of longitudinal optical phonon–plasmon coupling in GaN layers
N. Wieser, M. Klose, R. Dassow, F. Scholz and J. Off 661
Raman investigations of GaN films grown by pulsed laser deposition
M. Klose, R. Dassow, M. Gross and H. Schröder 666
Electronic properties in doped GaN studied by Raman scattering
H. Harima, H. Sakashita, T. Inoue and S.-i. Nakashima 672
HREELS analysis of the vibrational and electronic properties of GaN film on sapphire(0 0 0 1) grown by metalorganic chemical vapor deposition
T. Tsuruoka, N. Takahashi, R. Franchy, S. Ushioda, Y. Naoi, H. Sato, S. Sakai and Y. Shintani 677
Excitonic transitions in MBE grown h-GaN with cubic inclusions
S. Strauf, P. Michler, J. Gutowski, H. Selke, U. Birkle, S. Einfeldt and D. Hommel 682
Photoreflectance study of band-gap renormalization in Si-doped GaN[3]
X. Zhang, S.-J. Chua, W. Liu and K.-B. Chong 687
The influence of the Al-content on the optical gain in AlGaN heterostructures
J. Holst, L. Eckey, A. Hoffmann, O. Ambacher and M. Stutzmann 692
Lattice stability study of nitride semiconductors by the use of molecular dynamics calculation
S. Matsumura, T. Inushima and T. Shiraishi 696
Mechanical properties of the GaN thin films deposited on sapphire substrate
G. Yu, H. Ishikawa, T. Egawa, T. Soga, J. Watanabe, T. Jimbo and M. Umeno 701

SECTION XVIII. CONTACTS AND PROCESSING

Electrical characterization of n-GaN Schottky and PCVD-SiO_2/n-GaN interfaces
M. Sawada, T. Sawada, Y. Yamagata, K. Imai, H. Kimura, M. Yoshino, K. Iizuka and H. Tomozawa 706
Effect of metal type on the contacts to n-type and p-type GaN
J. Rennie, M. Onomura, S.-y. Nunoue, G.-i. Hatakoshi, H. Sugawara and M. Ishikawa 711
Crystal orientation dependence of p-type contact resistance of GaN
N. Mochida, T. Honda, T. Shirasawa, A. Inoue, T. Sakaguchi, F. Koyama and K. Iga 716
Effects of titanium silicide on AuSiTi/n-GaN ohmic contact systems
C.Y. Kim, S.-W. Kim, C.-H. Hong, D.-W. Kim, H.-K. Baik and C.N. Whang 720
Study on high-speed deep etching of GaN film by UV laser ablation
J. Zhang, K. Sugioka, S. Wada, H. Tashiro and K. Midorikawa 725
Etching of cubic GaN by annealing in hydrogen ambient
H. Tanaka and A. Nakadaira 730
Anodic etching of n-type GaN films in NaOH electrolyte with Cl ions
M. Ohkubo 734

SECTION XIX. ELECTRONIC DEVICES AND ELECTRICAL PROPERTIES

An AlN/GaN insulated gate heterostructure field effect transistor with regrown n^+GaN source and drain contact
H. Kawai, M. Hara, F. Nakamura, T. Asatsuma, T. Kobayashi and S. Imanaga 738
One-dimensional simulation of charge control in a novel AlN/GaN insulated gate heterostructure field effect transistor with modulation doping
S. Imanaga and H. Kawai 742
Optical and electrical properties of nano-crystalline GaN thin films and their application for thin-film transistor
S. Kobayashi, S. Nonomura, K. Ushikoshi, K. Abe, M. Nishio, H. Furukawa, T. Gotoh and S. Nitta 749
Photoconductivity in n-type modulation-doped GaN/AlGaN heterostructures
A.V. Buyanov, J.P. Bergman, J.A. Sandberg, B.E. Sernelius, P.O. Holtz, J. Dalfors, B. Monemar, H. Amano and I. Akasaki 753
Weakly localized transport in modulation-doped GaN/AlGaN heterostructures
A.V. Buyanov, J.A. Sandberg, B.E. Sernelius, P.O. Holtz, J.P. Bergman, B. Monemar, H. Amano and I. Akasaki 758
Impact of defects on the carrier transport in GaN
M. Fehrer, S. Einfeldt, U. Birkle, T. Gollnik and D. Hommel 763
Minority carrier diffusion length in GaN and ZnSe
T. Miyajima, M. Ozawa, T. Asatsuma, H. Kawai and M. Ikeda 768
Electrical properties of n-GaN/n^+-GaAs interfaces
Y. Kribes, I. Harrison, B. Tuck, T.S. Cheng and C.T. Foxon 773

SECTION XX. LEDs AND RECOMBINATION MECHANISM

High-power UV InGaN/AlGaN double-heterostructure LEDs[3]
T. Mukai, D. Morita and S. Nakamura 778
Device performance of ultra-violet emitting diodes grown by MBE
M. Mayer, A. Pelzmann, C. Kirchner, M. Schauler, F. Eberhard, M. Kamp, P. Unger and K.J. Ebeling 782
High-efficiency InGaN MQW blue and green LEDs
S.D. Lester, M.J. Ludowise, K.P. Killeen, B.H. Perez, J.N. Miller and S.J. Rosner 786
Recombination dynamics in GaN
O. Brandt, H.-J. Wünsche, H. Yang, R. Klann, J.R. Müllhäuser and K.H. Ploog 790
Magnetic resonance studies of GaN-based LEDs
W.E. Carlos and S. Nakamura 794
Light emitting diodes as a monitor to study P-type doping of GaN-based heterostructures grown by MOVPE
B. Schineller, A. Guttzeit, F. Vertommen, O. Schön, M. Heuken, K. Heime and R. Beccard 798
Comprehensive studies of light emission from GaN/InGaN/AlGaN single-quantum-well structures
M. Osiński, P. Perlin, P.G. Eliseev, J. Lee and V.A. Smagley 803
Effects of high electrical stress on GaN/InGaN/AlGaN single-quantum-well light-emitting diodes
M. Osiński, D.L. Barton, P. Perlin and J. Lee 808
Blue radiative recombination due to hot electrons in InGaN single-quantum well LEDs
H. Kudo, Y. Yamada and T. Taguchi 812
Frequency dependence of the reverse-biased capacitance of blue and green light-emitting diodes
Y. Zohta, H. Kuroda, R. Nii and S. Nakamura 816

SECTION XXI. NITRIDE LASERS

Present status of InGaN/GaN/AlGaN-based laser diodes[2]
S. Nakamura, M. Senoh, S.-i. Nagahama, N. Iwasa, T. Yamada, T. Matsushita, H. Kiyoku, Y. Sugimoto, T. Kozaki, H. Umemoto, M. Sano and K. Chocho 820
InGaN laser diode grown on 6H-SiC substrate using low-pressure metalorganic vapor phase epitaxy
A. Kuramata, K. Domen, R. Soejima, K. Horino, S.-i. Kubota and T. Tanahashi 826
Stimulated emission with the longest wavelength in the blue region from GaInN/GaN multi-quantum well structures
H. Sakai, T. Takeuchi, S. Sota, M. Katsuragawa, M. Komori, H. Amano and I. Akasaki 831
Characteristics of indium-gallium-nitride multiple-quantum-well blue laser diodes grown by MOCVD[3]
M.P. Mack, A.C. Abare, M. Hansen, P. Kozodoy, S. Keller, U. Mishra, L.A. Coldren and S.P. DenBaars 837
Room-temperature pulsed operation of a GaInN multiple-quantum-well laser diode with optimized well number[3]
F. Nakamura, T. Kobayashi, T. Asatsuma, K. Funato, K. Yanashima, S. Hashimoto, K. Naganuma, S. Tomioka, T. Miyajima, E. Morita, H. Kawai and M. Ikeda 841
Dry-etching and characterization of mirrors on III-nitride laser diodes from chemically assisted ion beam etching
M. Kneissl, D. Hofstetter, D.P. Bour, R. Donaldson, J. Walker and N.M. Johnson 846

Author index 850

Subject index 865